JUVENILE SALMON AND NEARSHORE FISH USE IN SHALLOW INTERTIDAL HABITAT ASSOCIATED WITH HARRINGTON LAGOON, 2006

December, 2007

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2006 oblique aerial photo of Harrington Lagoon (courtesy WA Department of Ecology)

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ACKNOWLEDGEMENTS

The following people and organizations are to be thanked for their help with this study:

- Island County Washington State University (WSU) Beach Watchers for help with data collection: Bob Buck, Joani Boose, Jim Somers, Ken Urstad, Bill Pigott, Finn Gatewood, Tom Albrecht, Graham Johnson, Jill Hein and Marty Crowley; and the guidance/support of Kristen Cooley and Don Meehan.
- Skagit River System Cooperative staff: Rich Henderson and Bruce Brown for data entry; Karen Wolf and Aundrea McBride for help with maps, figures and edits.
- Island County Marine Resources Committee for help with coordination and buying limited supplies in support of WSU Beach Watchers volunteers.

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PURPOSE

Studies of fish use in pocket estuaries throughout the Whidbey Basin began in 2002. At first, research was limited to understanding juvenile Chinook salmon use of sites within Skagit Bay (Beamer et al. 2003). In 2004, studies were expanded to sites throughout the Whidbey Basin, Fidalgo Bay and Samish Bay via a cooperative effort that was partially funded by the Northwest Straits Commission[1]. The focus of the expanded research is to understand landscape scale patterns of fish usage including what species and life history types use these systems, how connectivity or position within the larger landscape affects this use, and how patterns of use can relate to protection and restoration of these systems. Use of Island County WSU Beach Watchers volunteers helped expand this research effort from 2005 through 2007 and included sampling in Harrington Lagoon. The focus of this report is on fish abundance and size in Harrington Lagoon during 2006, a similar report using 2005 data was published in June, 2006 (Beamer et al. 2006). Although we primarily report only fish abundance and size in this one system, we will also briefly consider results within the context of the larger Whidbey Basin study of pocket estuaries. The results of this study can be used to inform local citizens about fish populations currently using the Harrington Lagoon area. The results are useful to Island County, and other agencies and groups interested in Puget Sound salmon recovery and nearshore ecology.

STUDY AREA

Harrington Lagoon is located on the eastern shoreline of Whidbey Island, in Saratoga Passage (Figure 1). This approximately 8.5 acre longshore coastal lagoon is located behind the leeward side of a spit beach formed by accreting sediments that originate from bluff-backed beaches south of the lagoon. Historically Harrington Lagoon was connected to Saratoga Passage via an outlet channel located near its northwest end. Under contemporary conditions, the Harrington Lagoon outlet channel is located roughly along the middle of the lagoon's outer margin. The northwest end of the historic lagoon is mostly developed with homes and the old outlet channel is no longer present.

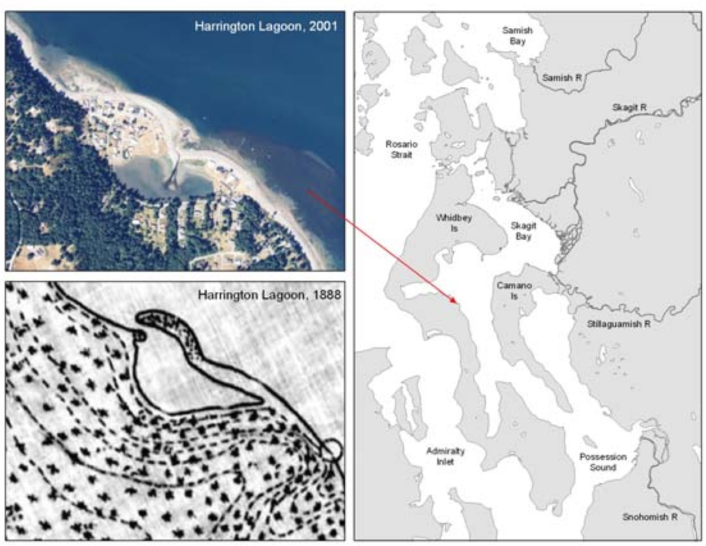


Figure 1. Location of Harrington Lagoon on the eastern Whidbey Island shoreline, along with contemporary (2001) and historic (1888) views of the site. The 2001 view is from an aerial photo, Washington Department of Natural Resources, Olympia, Washington. The 1888 view is from T-sheet # 2011 from the U.S. Coast and Geodetic Survey, available at the Puget Sound River History Project (http://riverhistory.ess.washington.edu).

[1] This effort included Skagit River System Cooperative, NOAA Northwest Fisheries Science Center, Stillaguamish Tribe, Tulalip Tribes, and Samish Nation. Results are reported in Beamer et al. (2006).

METHODS

Nearshore areas like Harrington Lagoon and its vicinity can potentially have many different local-scale habitat types based on variations in water depth, aquatic vegetation, substrate, protection from wave energy and freshwater inputs (creeks or seeps). We illustrate these differences using a conceptual nearshore beach cross-section that includes a lagoon impoundment behind a spit beach, similar to Harrington Lagoon (Figure 2). The different habitat types within this nearshore cross-section require different methods to effectively sample the fish assemblage. Small beach seines can be used to sample for fish in shallow intertidal areas within the lagoon impoundment or along the outside of the spit beach (Figures 2A and 2B). Larger beach seines can sample the deeper habitat of the intertidal–subtidal fringe. Tow nets, or other non-shoreline-oriented gear, can be used to sample offshore areas. Fyke traps can be used to catch fish in tidal creeks or blind tidal channels that are often present along the margins of lagoon habitats. Photos of each method and their respective net dimensions are found within a methods paper published by Skagit System Cooperative (2003).

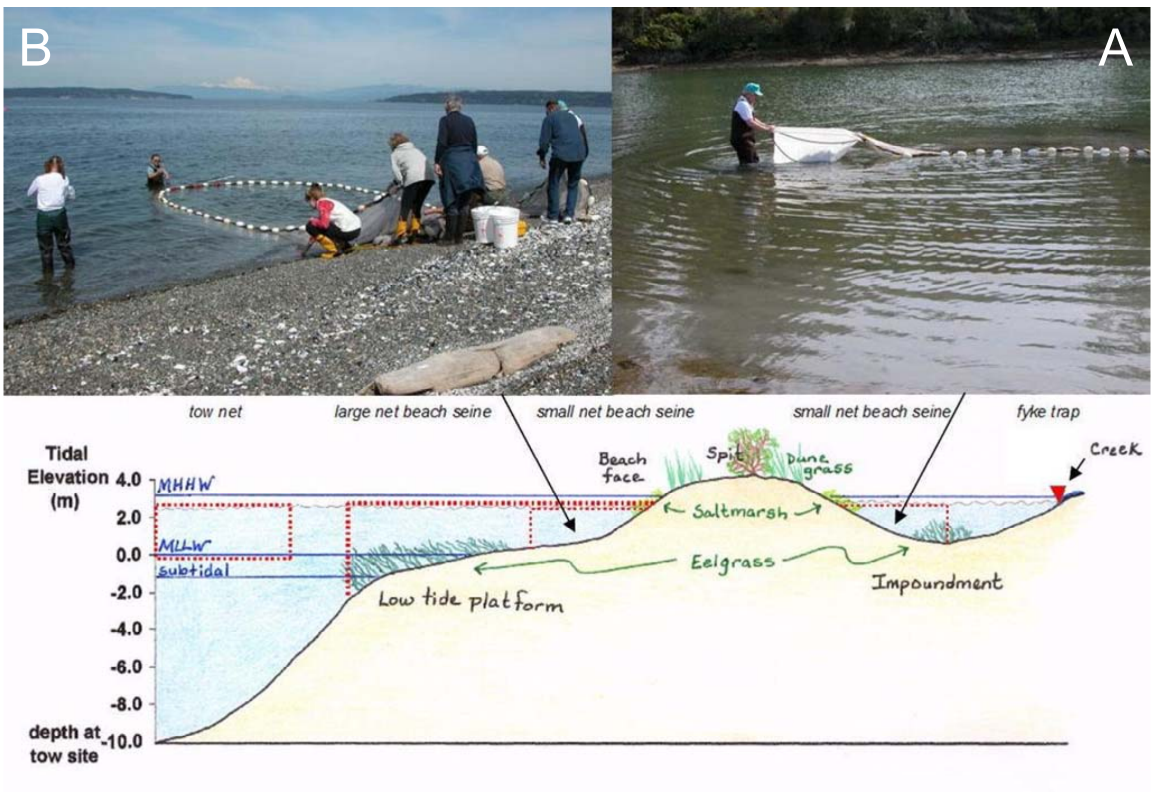


Figure 2. WSU Beach Watcher volunteers working with NOAA staff to beach seine sites at Harrington Lagoon. The diagram is a cross-sectional view of a nearshore beach that includes an impoundment similar to Harrington Lagoon. The red dotted lines illustrate the relative difference in depth, cross-sectional area of the water column, and position along the nearshore continuum that each gear type effectively samples. The different gear types are labeled directly above the red dotted lines. The two photos are of small net beach seine sets from (A) within Harrington Lagoon and (B) its adjacent shallow nearshore habitat. Harrington Lagoon does not have a creek flowing into the lagoon or blind tidal channels, therefore we do not use fyke trap methods at this site. This study did not sample any deeper nearshore or offshore habitat adjacent to Harrington Lagoon.

This study focused on only two of five habitat types shown in Figure 2 (briefly described above). We attempted to sample twice a month, February through May, using a small beach seine within Harrington Lagoon and its adjacent shallow intertidal nearshore habitat. The study did not sample the deeper intertidal-subtidal fringe habitats with larger beach seines or offshore habitat with tow nets. No tidal creeks or blind tidal channels are present within Harrington Lagoon, so use of fyke traps was not necessary.

The specific beach seine locations are shown in Figure 3. The areas seined are typically less than four feet deep (1.2 m) and have relatively homogeneous habitat features (water depth, velocity, substrate, and vegetation). Small net beach seine methodology uses an 80-foot (24.4 m) by 6-foot (1.8 m) by 1/8-inch (0.3 cm) mesh knotless nylon net. The net is set in "round haul" fashion by fixing one end of the net on the beach while the other end is deployed by wading "upstream" against the water current (if present), hauling the net in a floating tote (Figure 2A) and then returning to the shoreline in a half circle. Both ends of the net are then retrieved (Figure 2B), yielding a catch. One beach seine set was made at each site per sampling day. Average beach seine set area is 96 square meters.

For each beach seine set, we identified and counted the catch by species and sub-sampled individual fish lengths by species. We also recorded the time and date of each beach seine set and measured several physical habitat parameters associated with each set, including:

- Tidal stage (ebb, flood, high, low)
- Substrate type defined as follows (based on Skagit System Cooperative 2003):
    - Gravel - 75% of the surface is covered by clasts 4 to 64mm in diameter.
    - Mixed Coarse - No one size comprises > 75% of surface area. Cobbles and boulders are >6%.
    - Mixed Fines - Fine sand, silt, and clay comprise 75% of the surface area, with no one size class being dominant. May contain gravel (<15%). Cobbles and boulders make up <6%. Not difficult to walk on without sinking.
    - Mud - Silt and clay comprise 75% of the surface area. Often anaerobic, with high organic content. Tends to pool water on the surface and be difficult to walk on without sinking.
- Vegetation type defined as follows:
    - Saltmarsh – Vegetated sites dominated by Pickleweed.
    - Unvegetated
- Surface and bottom water temperature of the area seined using YSI meter.
- Surface and bottom salinity of the area seined using YSI meter.
- Maximum depth of area seined

Beach seine sites were selected both within Harrington Lagoon and its adjacent nearshore (Figure 3). The sampling sites were selected to compare the fish assemblage, including juvenile salmon, within the lagoon and outside the lagoon (the adjacent nearshore habitat). In this report results (biotic and abiotic) are summarized as monthly averages (means) or frequency distributions for the combined sites within the lagoon or sites within the nearshore habitat adjacent to the lagoon.

Figure 3. Location of beach seine sites at Harrington Lagoon, 2006. Yellow circles represent sites within Harrington Lagoon. White squares represent sites in the adjacent nearshore. The photo was taken at extreme low tide. Beach seining was always done at the water's edge, independent of tidal stage.

Results and Discussion

Beach Seine Effort

The Harrington Lagoon sampling effort in 2006 consisted of 72 beach seine sets made during the February through May time period (Table 1). Beach seine effort within the lagoon was approximately 88% greater than the effort in adjacent shallow nearshore based on the number of sites sampled in the lagoon each sampling trip.

Table 1. Summary of beach seine sampling effort at Harrington Lagoon sites in 2006.

A - Sampling effort (number of beach seine sets)		
Month	Adjacent nearshore	Lagoon
February	8	12
March	6	11
April	6	12
May	5	12
Total	25	47

Environmental Conditions During Beach Seine Sampling

Tidal Stage, Water Depth, and Substrate

The majority of beach seine sampling occurred on ebb (receding) tides (Table 2A) at depths shallower than one meter of water (Table 2B). The beach seined sites inside the lagoon were over finer grained substrate (mixed fines) than adjacent nearshore sites, which consisted mostly of gravel (Table 2C).

Table 2. Summary of tidal stage, water depth and substrate conditions during the time of beach seine sampling at Harrington Lagoon sites in 2006.

A - Percentage of beach seine sets by tidal stage		
Tidal Stage	Adjacent nearshore	Lagoon
Ebb	60.0%	87.2%
Flood	0.0%	0.0%
High	40.0%	12.8%
Low	0.0%	0.0%
B - Maximum depth of area beach seined		
	Adjacent nearshore	Lagoon
Average and 1 standard deviation (in parentheses)	0.70 (0.17) meters	0.49 (0.17) meters
C - Percentage of beach seine sets by substrate type		
Substrate Type	Adjacent nearshore	Lagoon
Gravel	88.0%	0.0%
Mixed Coarse	0.0%	0.0%
Mixed Fines	12.0%	100%
Mud	0.0%	0.0%

The different substrates reflect differences in wave energy between the lagoon and its adjacent nearshore. The lagoon is more protected from waves so finer grained sediments are retained in the lagoon whereas higher wave energy transports the finer grained sediment off the beach face of the adjacent nearshore beach, leaving coarser grained substrate.

Temperature and Salinity

Monthly patterns of surface salinity and surface water temperature in Harrington Lagoon and its adjacent nearshore are shown in Figures 4A and 4B. Skagit River flow, which accounts for the majority of freshwater entering the Whidbey Basin, is shown in Figure 4C. The salinity and temperature measurements are snapshot measurements taken during beach seine activities.

We find little evidence that Harrington Lagoon salinity is consistently different (higher or lower) than salinity in the adjacent shallow nearshore. 2006 data suggests a slight seasonal increase in salinity for both habit types over the four month period (February – May). Salinity patterns at Harrington Lagoon are likely driven by local evaporation rates within Harrington Lagoon during low tide cycles. More frequent salinity monitoring might reveal differences in salinity between the lagoon and adjacent nearshore habitat due to this factor.

Water temperature within the lagoon and adjacent nearshore show a seasonal increase from February through May (Figure 4B). In May, the lagoon surface water was warmer than the surface water in the adjacent nearshore by about 1 degree C.

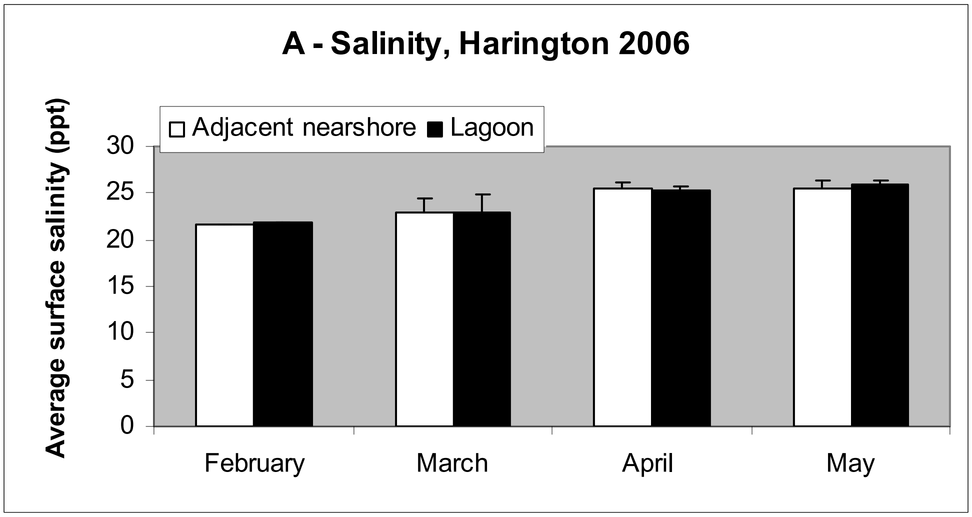


Figure 4A. Average salinity at Harrington Lagoon taken at the beach seine sites during the time of beach seining. White bars are results for the shallow nearshore adjacent to the lagoon. Black bars are results for habitat within the lagoon. Error bars are one standard deviation.

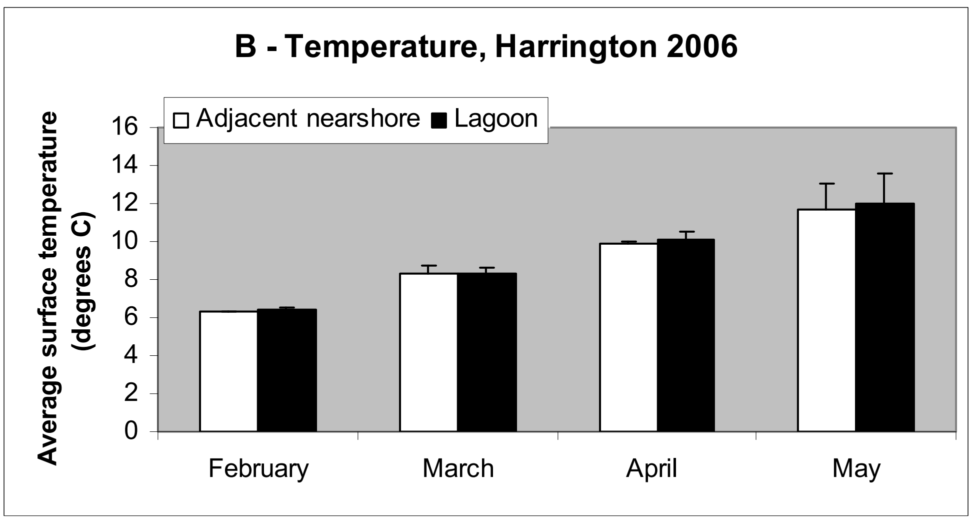


Figure 4B. Average temperature at Harrington Lagoon taken at the beach seine sites during the time of beach seining. White bars are result for the shallow nearshore adjacent to the lagoon. Black bars are results for habitat within the lagoon. Error bars are one standard deviation.

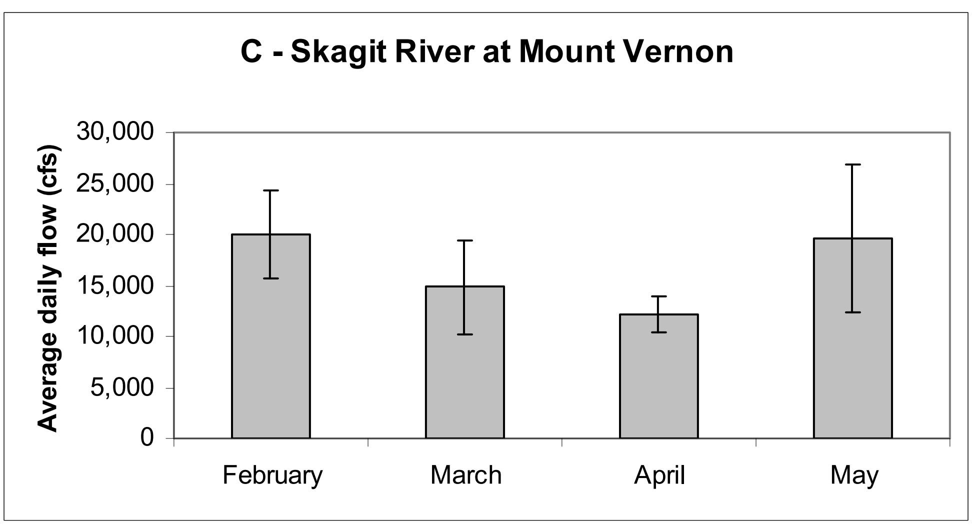


Figure 4C. Monthly flow of the Skagit River at Mount Vernon for 2006. Error bars are plus and minus one standard deviation.

Catch by Species

We caught over 3,000 fish representing at least 12 different species during the sampling period February through May, 2006 (Table 3). Juvenile salmon represented about 22% of the total catch. The juvenile salmon catch was dominated by subyearling pink salmon. Subyearling chum and Chinook salmon were also caught. We will discuss juvenile pink, chum and Chinook salmon later in this report.

Sculpins, primarily Pacific staghorns, accounted for 62% of the total catch. Based on catch per unit effort (CPUE) calculated as fish per beach seine set, sculpins were over 15 times more abundant in the lagoon than in the adjacent shallow nearshore habitat. Flatfish, primarily starry flounder, were not dominant in our catches (accounting for less than 0.1% of the total catch), but were caught only in the lagoon. Shiner perch accounted for 5% of the total catch. Based on CPUE, shiner perch were nearly five times more abundant in the lagoon than in the adjacent shallow nearshore habitat. Surf smelt accounted for 7% of the total catch. Based on CPUE, surf smelt were over 11 times more abundant in the lagoon than in the adjacent shallow nearshore habitat. Three-spine stickleback accounted for about 1% of the total catch. Based on CPUE, sticklebacks were over 10 times more abundant in the lagoon than in the adjacent shallow nearshore habitat. Arrow goby accounted for 2% of the total catch. Based on CPUE, Arrow goby were over 35 times more abundant in the lagoon than in the adjacent shallow nearshore habitat.

Table 3. Total fish catch (and mean catch per beach seine set in parentheses) by fish species at Harrington sites in 2006.

Fish species	**Adjacent nearshore**	**Lagoon**
Juvenile salmon:		
Chum salmon, subyearling *Oncorhynchus keta*	12 (0.48)	94 (2.0)
Chinook salmon, unmarked subyearling *Oncorhynchus tshawytscha*	2 (0.08)	46 (0.98)
Pink salmon, subyearling *Oncorhynchus gorbuscha*	151 (6.04)	371 (7.89)
Total juvenile salmon	165 (6.60)	511 (10.87)
Sculpin species:		
Pacific staghorn sculpin *Leptocottus armatus*	57 (2.28)	1840 (39.15)
Buffalo sculpin *Enophrys bison*	3 (0.12)	0 (0.0)
Sharpnose sculpin *Clinocottus acuticeps*	2 (0.08)	1 (0.02)
Unidentified sculpin	0 (0.0)	3 (0.06)
Total sculpins	62 (2.48)	1844 (39.23)
Flatfish species:		
Starry flounder *Platichtys stellatus*	0 (0.0)	4 (0.09)
Total flatfish	0 (0.0)	4 (0.09)
Forage fish species:		
Surf smelt, unknown age *Hypomesus pretiosis*	6 (0.24)	103 (2.19)
Surf smelt, post larval *Hypomesus pretiosis*	4 (0.16)	109 (2.32)
Total forage fish	10 (0.40)	212 (4.51)
Other nearshore or estuarine fish species:		
Shiner perch *Cymatogaster aggregate*	17 (0.68)	145 (3.09)
Threespine stickleback *Gasterosteus aculeatus*	2 (0.08)	38 (0.81)
Gunnel *Pholis laeta*	0 (0.0)	1 (0.02)
Arrow goby *Clevelandia ios*	1 (0.04)	67 (1.43)
Total catch	257 (10.28)	2,822 (60.04)

Juvenile pink salmon

In this section we discuss the timing, abundance and size of juvenile pink salmon in Harrington Lagoon and its adjacent shallow nearshore habitat.

<u>Timing and Abundance</u>

Juvenile pink salmon were present in either the lagoon or its adjacent shallow nearshore habitat during the entire four month sampling period of February through May, 2006 (Figure 5). Juvenile pink salmon were caught in Harrington Lagoon habitat and not in its adjacent shallow nearshore habitat in February. Pink salmon abundance was low during this time. Peak pink salmon abundance in the lagoon and its adjacent shallow nearshore habitat occurred in April. Pink salmon abundance considerably declined in May in the shallow nearshore habitat, and no pink salmon were caught during May in the Harrington Lagoon habitat.

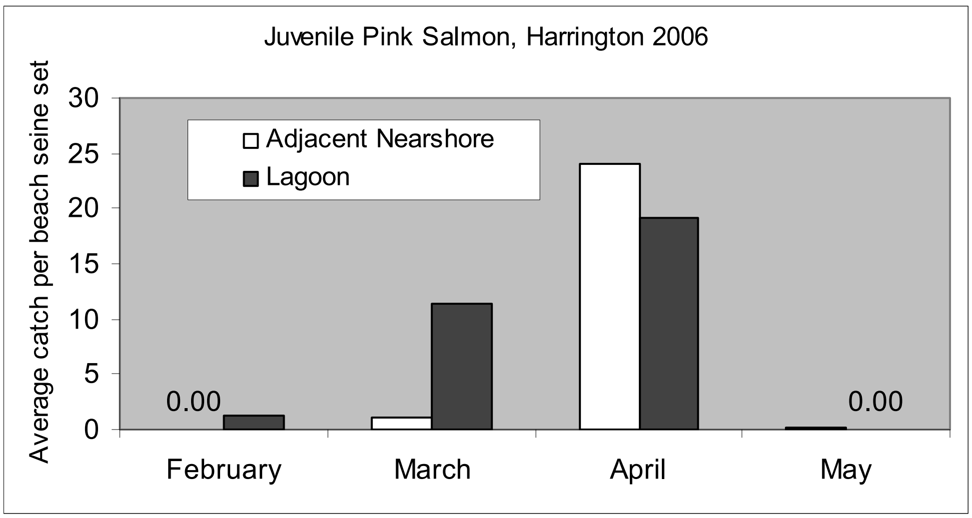


Figure 5. Average juvenile pink salmon CPUE for Harrington Lagoon and its adjacent nearshore habitat, 2006.

Fish Size

The size of pink salmon was characterized by measuring fork length on 174 of the 522 juvenile pink salmon caught at the Harrington Lagoon sites (Table 4, Figure 6). Median values are reported for all fish length data.

Table 4. Number of juvenile pink salmon fork length samples collected at Harrington Lagoon sites, 2006.

Month	Adjacent nearshore	Lagoon
February	0	16
March	6	20
April	40	91
May	1	0
Total	47	127

In February of 2006 juvenile pink salmon were caught only at lagoon sites (Figure 5 & 6A). They ranged from 32 to 44 mm fork length with a median length of 34 mm. Length frequency results for pink salmon caught in February are skewed towards a higher percentage of smaller fish.

In March and April of 2006 juvenile pink salmon were caught in both lagoon and adjacent shallow nearshore sites (Figure 5, 6B, and 6C). In March, juvenile pink salmon caught at lagoon sites ranged from 31 to 46 mm fork length with a median length of 40 mm while pink caught at adjacent nearshore sites ranged from 32 to 45 mm fork length with a median length of 33 mm. In April, juvenile pink salmon caught at lagoon sites ranged from 31 to 46 mm fork length with a median length of 35 mm while pink caught at adjacent nearshore sites ranged from 32 to 54 mm fork length with a median length of 35 mm.

In May of 2006 only 1 juvenile pink salmon was caught from the shallow nearshore habitat and none were caught from the lagoon sites (Figure 5).

The monthly pink salmon length results suggest there were probably two groups of juvenile pink salmon using the Harrington Lagoon area during February through May of 2006. The first group are those in the lagoon during February. In March, the fish in the lagoon tended to be larger (median moved from 34 to 40 mm) while outside of the lagoon they were small, more like the size of the fish in the lagoon during February. In April the fish were small in both habitat types, which suggests that these fish were part of a different group than the ones caught in the lagoon habitat during February and March.

Over a two-month period (March and April) we observed that the largest pink salmon reached, but never exceeded, the 46 – 50 mm range in Harrington Lagoon. The same pattern was observed for pink caught in adjacent shallow nearshore habitat, except for one individual caught in April (measuring 54 mm fork length). This may indicate that juvenile pink salmon do not reside in lagoon and shallow nearshore habitat after they reach the 46 - 50 mm fork length range or they have moved past these shallow habitats in the Harrington area before they reach a larger juvenile size. Also, there was always a fraction of the pink salmon catch that was very small-sized (40 mm fork length or less) over the February through April period, indicating that new pink salmon were arriving at the Harrington Lagoon area during each of these three months.

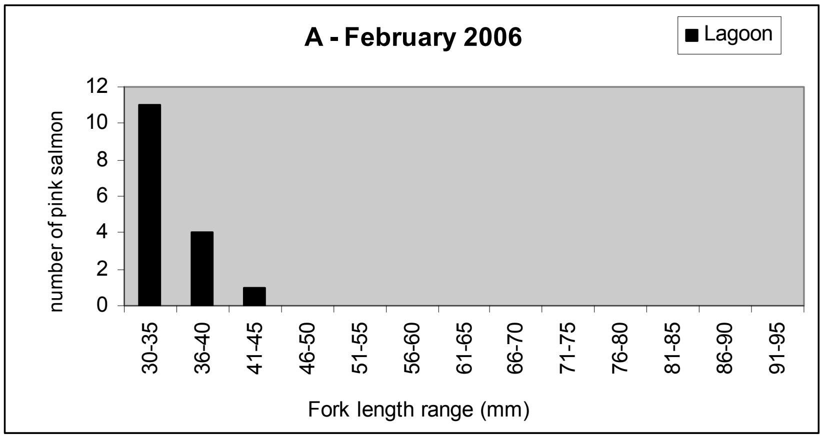


Figure 6A. Fork length frequency distribution of juvenile pink salmon captured at Harrington Lagoon sites in February, 2006. (Note: differing y-scales on all plots on this page)

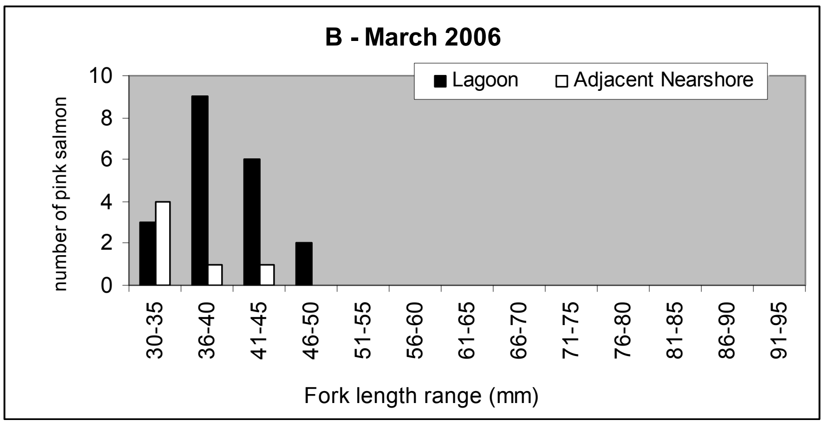


Figure 6B. Fork length frequency distribution of juvenile pink salmon captured at Harrington Lagoon sites in March, 2006.

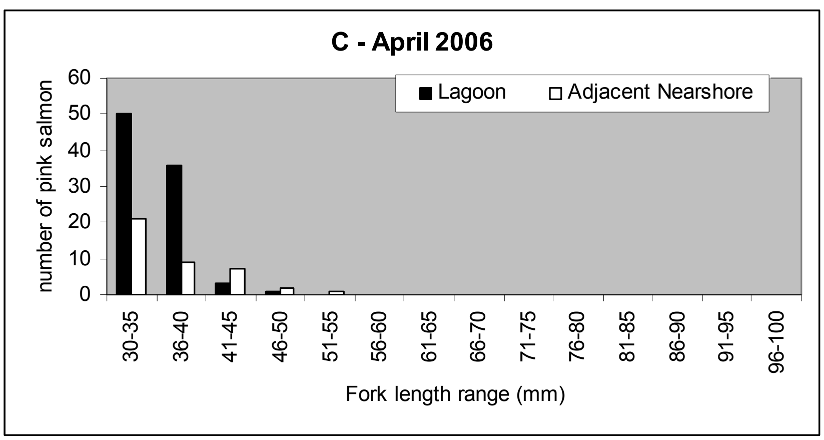


Figure 6C. Fork length frequency distribution of juvenile pink salmon captured at Harrington Lagoon in April, 2006.

Juvenile Chum

In this section we discuss the timing, abundance and size of juvenile chum salmon in Harrington Lagoon and its adjacent shallow nearshore habitat.

<u>Timing and Abundance</u>

Juvenile chum salmon were present in either the lagoon or its adjacent shallow nearshore habitat over the majority of the sampling period (Figure 7). Juvenile chum salmon were caught in Harrington Lagoon habitat and not in its adjacent shallow nearshore habitat during February and juvenile chum salmon were caught only in the adjacent shallow nearshore habitat in May. Chum salmon abundance was low during the months of February, March and May. Peak chum salmon abundance in the lagoon and its adjacent shallow nearshore habitat occurred in April.

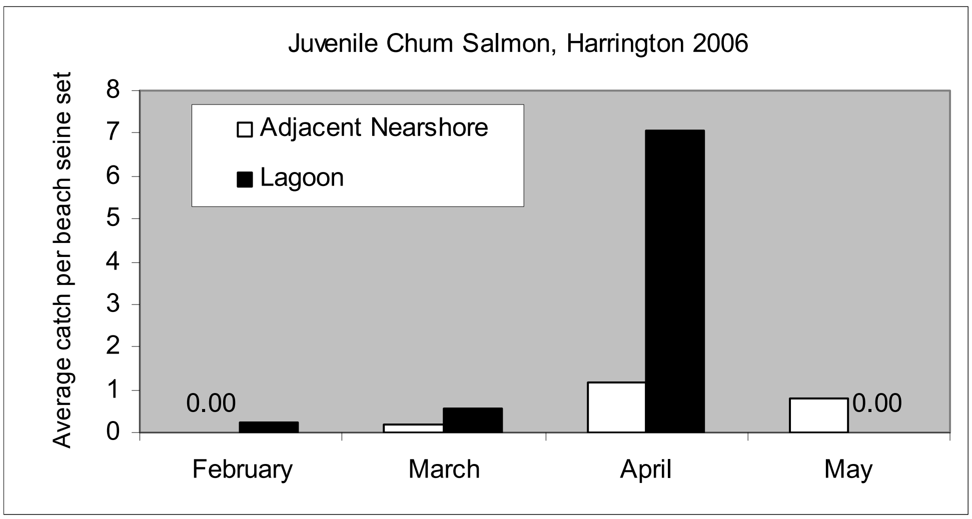


Figure 7. Average juvenile chum salmon CPUE for Harrington Lagoon and its adjacent nearshore habitat, 2006.

Fish Size

The size of chum salmon was characterized by measuring fork length on 74 of the 106 juvenile chum salmon caught at the Harrington Lagoon sites (Table 5, Figure 8).

Table 5. Number of juvenile chum salmon fork length samples collected at Harrington Lagoon sites, 2006.

Month	Adjacent nearshore	Lagoon
February	0	3
March	1	6
April	7	53
May	4	0
Total	12	62

In February of 2006 juvenile chum salmon were caught only at lagoon sites they ranged from 34 to 42 mm fork length (Figure 7 and 8A). In March, juvenile chum salmon caught at lagoon sites ranged from 36 to 43 mm. Only one juvenile chum was caught at the adjacent nearshore site in March.

In April of 2006 juvenile chum salmon were caught in both lagoon and adjacent shallow nearshore sites (Figure 7 and 8C). In April, juvenile chum salmon caught at lagoon sites ranged from 34 to 61 mm fork length with a median length of 40 mm. Length frequency results for chum salmon caught in April at the lagoon site are skewed towards a higher percentage of smaller fish. In May, juvenile chum salmon were only caught at adjacent nearshore sites and they ranged from 46 to 52 mm.

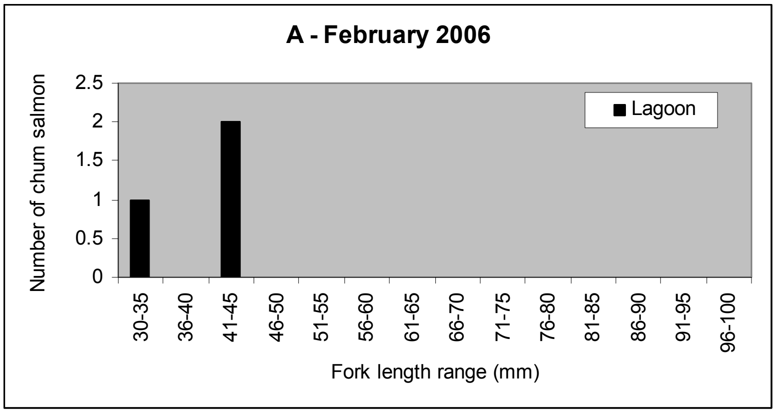


Figure 8A. Fork length frequency distribution of juvenile chum salmon captured at Harrington Lagoon sites in February, 2006. (Note: differing y-scales on all plots on this page)

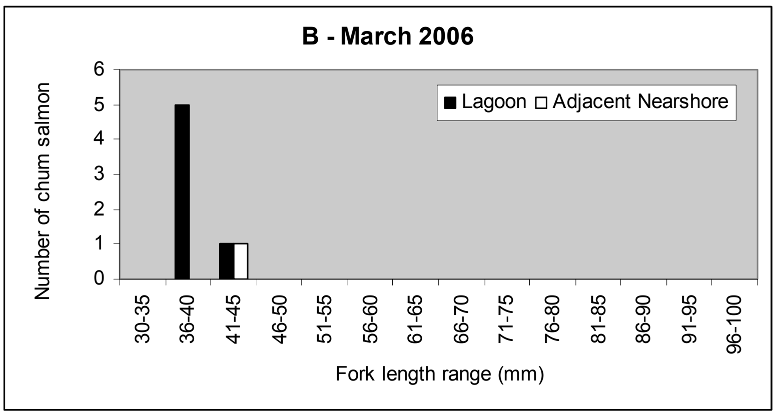


Figure 8B. Fork length frequency distribution of juvenile chum salmon captured at Harrington Lagoon sites in March, 2006. (Note: differing y-scales on all plots on this page)

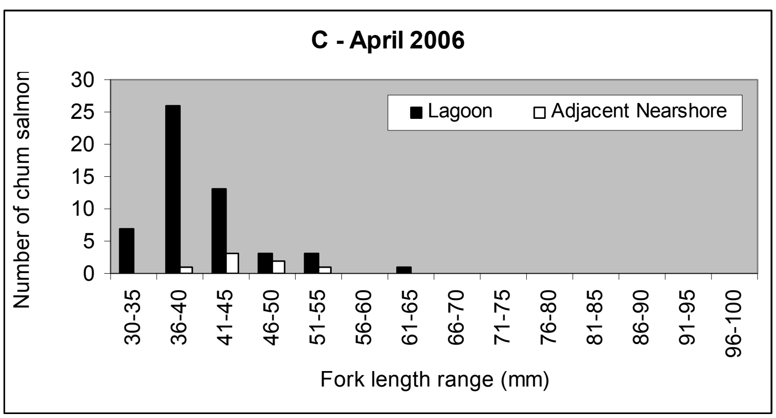


Figure 8C. Fork length frequency distribution of juvenile chum salmon captured at Harrington Lagoon sites in April, 2006.

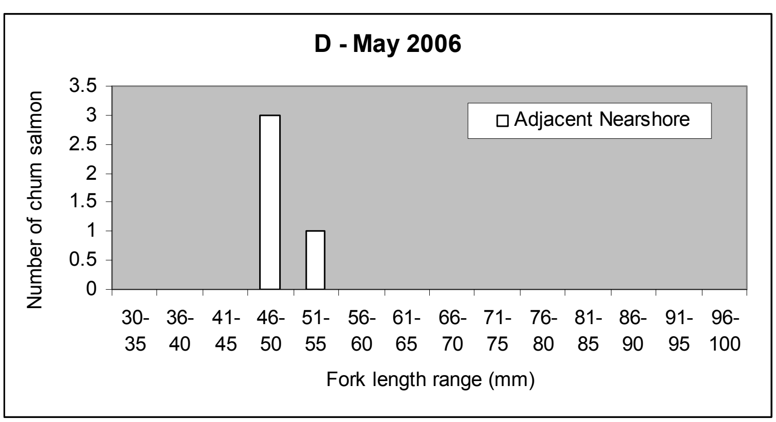


Figure 8D. Fork length frequency distribution of juvenile chum salmon captured at Harrington Lagoon sites in May, 2006.

Juvenile Chinook

In this section we discuss the timing, abundance and size of juvenile Chinook salmon in Harrington Lagoon and its adjacent shallow nearshore habitat.

Timing and Abundance

Juvenile Chinook salmon were present in either the lagoon or its adjacent shallow nearshore habitat during the entire sampling period (February through May). However, juvenile Chinook salmon were more abundant, based on CPUE results, in Harrington Lagoon habitat than in adjacent shallow nearshore in February through April. The timing curve and abundance pattern of juvenile Chinook salmon in Figure 9 is typical of lagoons nearer the Skagit River (Beamer et al. 2003). While the juvenile Chinook salmon period is somewhat abbreviated (peaked in February), it does coincide with the period when we would expect migrating Chinook salmon fry to be present in Saratoga Passage. Harrington Lagoon is over 18 kilometers from the mouth of the Skagit River (the nearest Chinook salmon river), and these results demonstrate that juvenile Chinook salmon use Harrington Lagoon habitat early in the year.

This study did not sample the deeper intertidal-subtidal fringe or offshore habitats adjacent to Harrington Lagoon. Therefore, we should not infer that the decline of juvenile Chinook salmon in the lagoon after March and the low Chinook salmon catches throughout the sampling period in adjacent shallow nearshore represents the pattern of juvenile Chinook salmon use in deeper or more offshore habitats adjacent to Harrington Lagoon. Rather, it is more likely that larger and older juvenile Chinook salmon are present in the deeper, more offshore habitats, following the pattern observed at similar sites where juvenile Chinook salmon transition from shallow to deeper habitats as they become larger later in the year (Beamer et al. 2003).

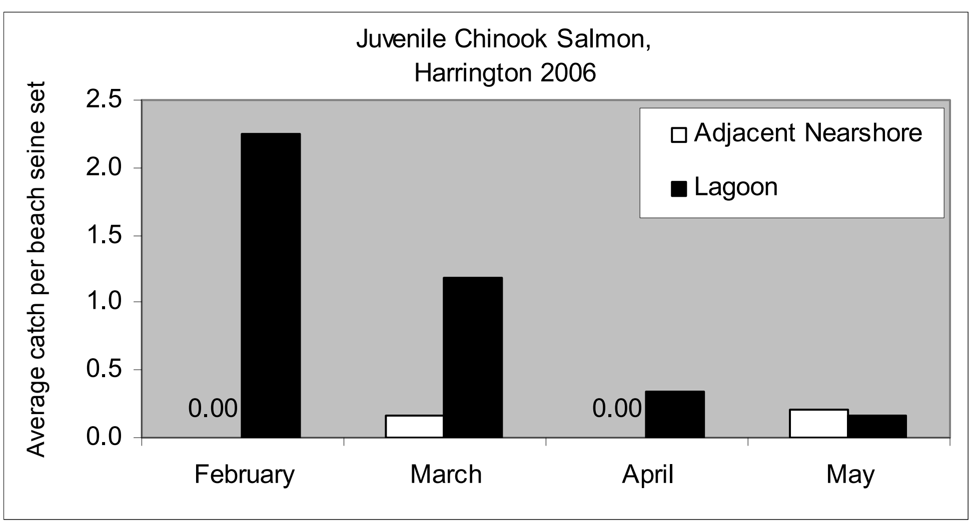


Figure 9. Average juvenile Chinook salmon CPUE for Harrington Lagoon and its adjacent nearshore habitat, 2006. All juvenile Chinook salmon captured were unmarked.

Fish Size

The size of Chinook salmon was characterized by measuring fork length on all 48 juvenile Chinook salmon caught at the Harrington Lagoon sites (Table 6, Figure 10). All juvenile Chinook salmon were subyearling sized.

Table 6. Number of juvenile Chinook salmon fork length samples collected at Harrington Lagoon sites, 2006.

Month	Adjacent nearshore	Lagoon
February	0	27
March	1	13
April	0	4
May	1	2
Total	2	46

We caught too few juvenile Chinook salmon in the shallow nearshore habitat adjacent to Harrington Lagoon to compare size to that of fish using the lagoon. However, there are sufficient numbers of juvenile Chinook salmon length samples from the lagoon sites in February and March to reasonably characterize the size of juvenile Chinook salmon using the lagoon during these months.

Juvenile Chinook salmon caught in Harrington Lagoon in February 2006 ranged from 36 to 52 mm fork length with a median length of 44 mm (Figure 10A). In March 2006, juvenile Chinook salmon caught in Harrington Lagoon ranged from 35 to 50 mm with a median fork length of 42 mm (Figure 10B). In April and May 2006 there were too few fish caught to describe the fork length distribution.

While few juvenile Chinook were caught after March (Figure 9), those that were caught in both the lagoon and its adjacent shallow nearshore were typically larger than the median size of juvenile Chinook caught in February and March (Figure 10). The fish captured after March appear to be from a different group of fish than those caught in the lagoon in February and March. This suggests that at least two different groups of juvenile Chinook salmon used the Harrington Lagoon area during 2006. The earlier group used the lagoon more extensively than the later group. The later group might have been much smaller in numbers.

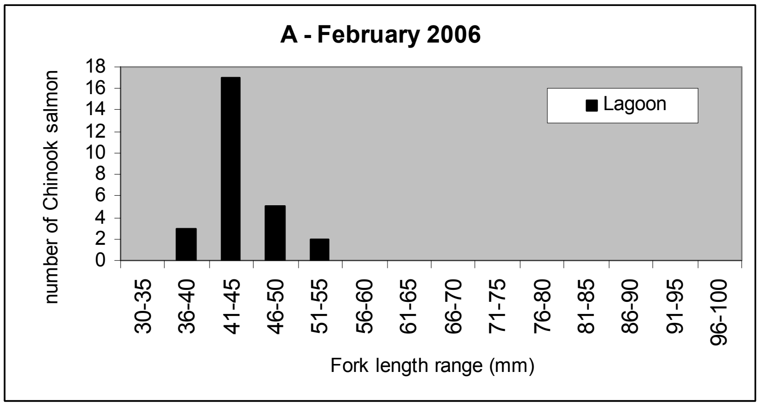


Figure 10A. Fork length frequency distribution of juvenile Chinook salmon captured at Harrington Lagoon sites in February, 2006. (Note: differing y-scales on all plots on this page)

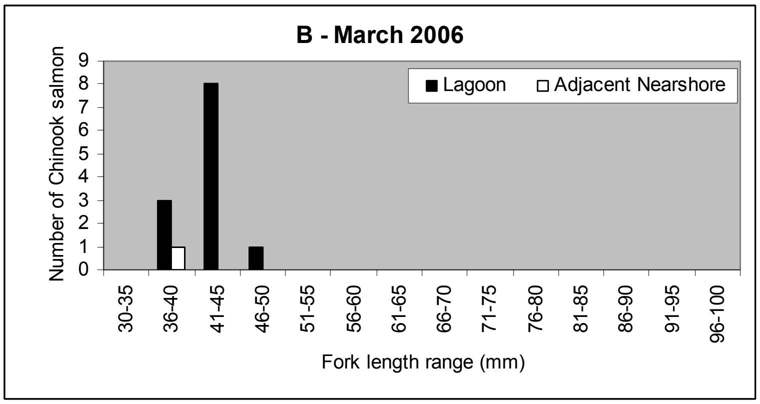


Figure 10B. Fork length frequency distribution of juvenile Chinook salmon captured at Harrington Lagoon sites in March, 2006.

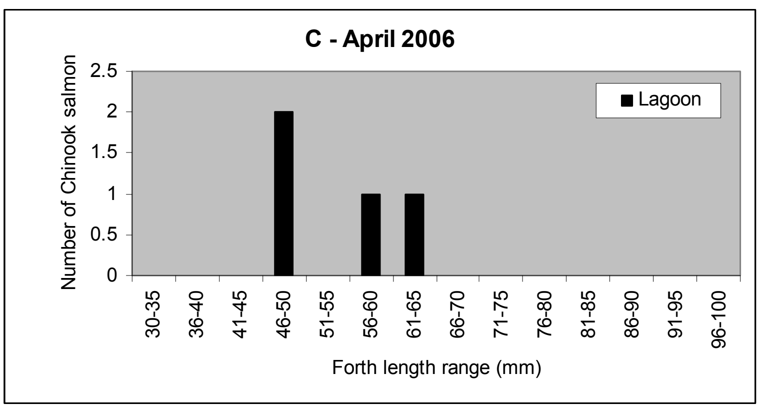


Figure 10C. Fork length frequency distribution of juvenile Chinook salmon captured at Harrington Lagoon sites in April, 2006.

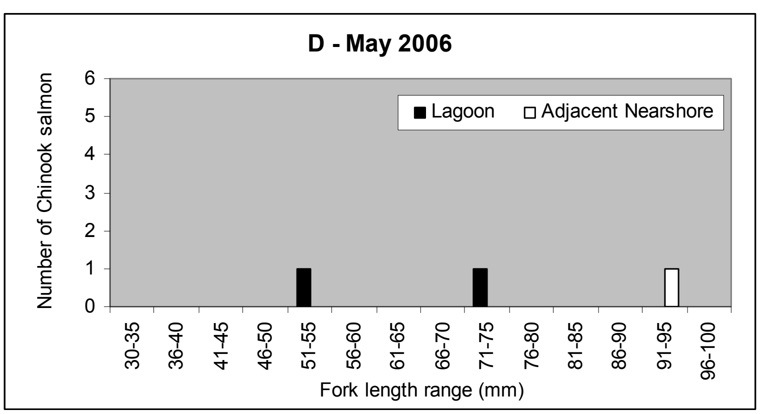


Figure 10D. Fork length frequency distribution of juvenile Chinook salmon captured at Harrington Lagoon sites in May, 2006.

Fish Assemblage Composition

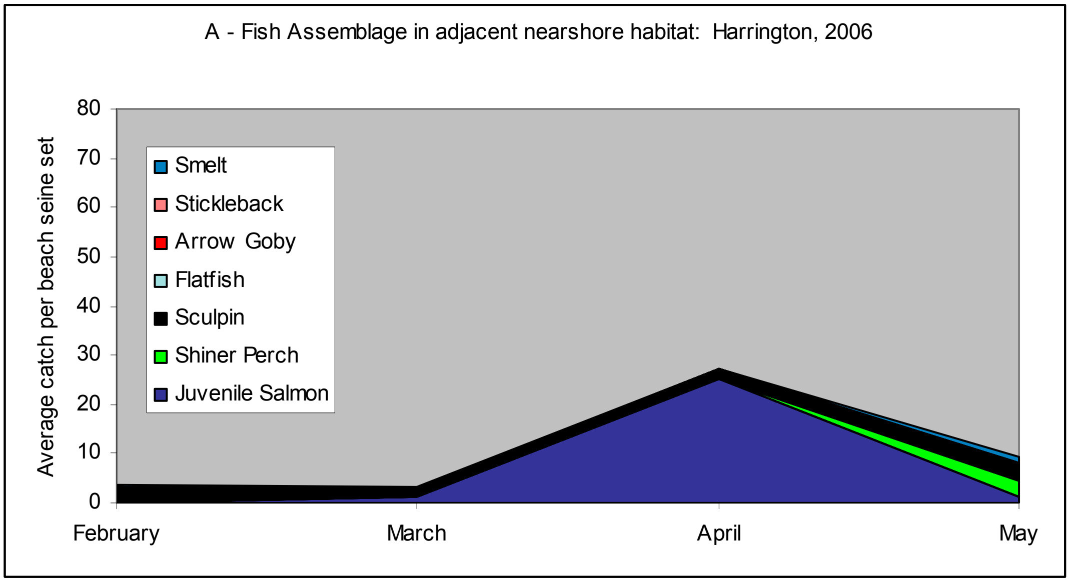
This section describes the fish assemblage composition over the February through May sampling period in 2006 for Harrington Lagoon sites and its adjacent shallow nearshore habitat. We selected six fish species, or species groups, that are either common nearshore fish species in Puget Sound or were common in the catch at the Harrington sites. The six species (or species groups) are: juvenile salmon, Shiner perch, sculpins, Arrow goby, Threespine stickleback and Surf smelt (Figure 11). The fish shown in Figure 11 represent nearly 98% of the total catch. In 2005 there were seven fish species that were common at the Harrington sites. Flatfish were more abundant in 2005 than in 2006 and were not considered a common species caught in 2006 (Beamer, Kagley, Fresh. 2006).

The shallow nearshore habitat adjacent to Harrington Lagoon had its lowest overall fish density in February and March and its peak in April. The peak fish density was driven primarily by juvenile pink salmon (Figures 5 and 11A). These sites had their highest species diversity in May when Shiner perch and a few stickleback, Arrow Goby and smelt were caught.

Harrington Lagoon habitat had its lowest overall fish density in March, but it was still 14 times higher than adjacent nearshore habitat (Figure 11B). Its highest overall fish density was in May when Shiner perch, Arrow goby, sculpins and smelt density increased. Peak fish density in lagoon habitat was 7.7 times higher than the fish density in adjacent shallow nearshore habitat at the same time. Species diversity was higher in lagoon habitat than adjacent shallow nearshore throughout the February through May sampling period.

At some time during spring to early summer, a juvenile salmon-dominated fish assemblage gives way to a Shiner perch-dominated assemblage. While this phenomenon was observed in 2005 (Beamer, Kagley, Fresh. 2006) it is not fully observed in Figure 11 for 2006. This is likely due to only beach seining through the month of May in 2006. Figure 11 show a complete juvenile salmon timing curve and Shiner perch are just beginning to show up in May. Shiner perch are a marine and estuarine species found throughout the Puget Sound region. Shiner perch typically show up in large schools in shallow nearshore areas in late spring or early summer for birthing where they stay through summer and early fall months before retreating to deeper marine waters during winter months. Other species, such as Arrow goby, seem to be associated with protected lagoon or soft substrate habitats. Pacific staghorn sculpin are generally a constant in the shallow nearshore environment, especially in finer grained substrate areas like those present in Harrington Lagoon. This year's results are consistent with patterns observed in 2005 (Beamer, Kagley, Fresh. 2006).

The low numbers of Surf smelt in the Harrington results stand out when compared to other sites studied in Skagit Bay or other parts of the Whidbey Basin. Beamer, McBride et al. (2006) reported Surf smelt were a common part of the fish assemblage within lagoon and adjacent shallow nearshore habitat at eight of nine sites sampled on a monthly basis in 2004. The 2004 study used the same beach seine methods as this study and sampled at a similar frequency and time of year. The 2004 study sites included four sites in Skagit Bay and one site each in Port Susan, Penn Cove, Saratoga Passage, Possession Sound, and Samish Bay. In the 2004 study, the Skagit Bay and Penn Cove sites were sampled longer than the February through June time period sampled for this Harrington study. Surf smelt were common both early in the year and again in fall months at the Skagit Bay and Penn Cove sites, so it is possible that Surf smelt were using the Harrington Lagoon area after beach seining ended in May of 2006.



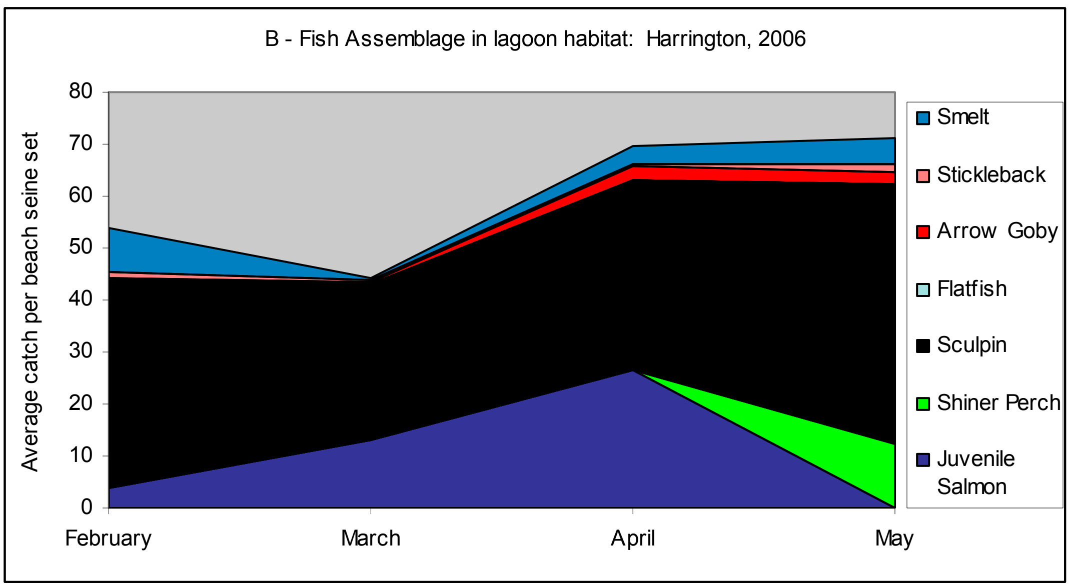


Figure 11. Monthly average fish assemblage composition and abundance for (A) adjacent shallow nearshore habitat and (B) Harrington Lagoon, 2006. Results are the average fish catch per beach seine set of seven possible species or specie groups displayed using a filled line graph where the catch per set of individual species and the total fish assemblage are visible. In Harrington Lagoon (Figure B), for example, we caught an average of 71 total fish per beach seine set in May, where 5 were smelt, 50 were sculpin, 12 were Shiner perch and the remaining 4 fish were minor amounts of Stickleback, Arrow Goby and Juvenile salmon (5+50+12+4=71).

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